IN-LINE ROLLER SKATE BRAKING MECHANISM

by

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FIELD OF THE INVENTION

This invention relates generally to skates and, more particularly, to braking mechanisms for skates, especially for in-line roller skates.

BACKGROUND OF THE INVENTION

In-line roller skates have become very popular. A problem persists with respect to in-line roller skates, however, regarding the inability of an in-line roller skate to stop efficiently as can an ice skate. In-line roller skates cannot stop quickly and efficiently like ice

skates, because in-line roller skates cannot brake by turning one or, preferably, both of the skates transverse to the direction of travel.

Accordingly, there is a need for a braking mechanism for in-line roller skates which avoids this problem in the prior art.

SUMMARY OF THE INVENTION

The invention is a braking system for a skate, such as an in-line roller skate. Typically, such a skate has a base skating surface with a base skating surface longitudinal axis. The braking mechanism comprises (a) at least one braking wheel disposed above the base skating surface, the at least one braking wheel being rotatable about a braking wheel axis disposed in a vertical plane, the vertical plane intersecting the base skating surface longitudinal axis at an angle of between about -20° and about +20°; (b) a piston housing having piston housing side walls, a first piston housing section proximal to a first piston housing end and a second piston housing section distal to the first piston housing end, the first piston housing section defining a plurality of first piston housing section side wall apertures, the first piston housing section side wall apertures being disposed at a plurality of different distances from the piston housing first end, the second piston housing section comprising one or more second piston housing section side wall apertures; (c) a piston disposed within the piston housing, the piston having a first end and a second end, the first end comprising an internal piston flow channel and a slide valve disposed in the first end of the piston for controlling the flow of liquid from the piston flow channel to the first piston housing section, the piston further comprising one or more piston inlet channels for allowing the flow of liquid into the piston flow channel from the second piston housing section, the piston being mechanically connected to the at least one braking wheel such that the rotation of the at least one braking wheel moves

the piston within the piston housing between (i) a first piston position wherein the piston is distal from the first piston housing end and wherein the piston is not adjacent to the first piston housing section side wall apertures, and (ii) a second piston position wherein the piston is proximal to the first piston housing end and the piston is adjacent to some or all of the first piston housing section side wall apertures, the slide valve being adapted to close when the piston is moved from the first piston position to the second piston position and to open when the piston is moved from the second piston position to the first piston position; (d) a first biasing mechanism for urging the piston towards the first piston position; (e) sealing means for sealing the piston within the piston housing such that (i) liquid disposed in the first piston housing section cannot leak around the piston to the second piston housing section, and (ii) when the piston is moved adjacent to one of the plurality of first piston housing section side wall apertures, liquid disposed in the first piston housing section cannot leak around the piston and out through that first piston housing section side wall aperture; and (f) an external flow channel having a first end a second end, the first end of the external flow channel being in fluid tight communication with the first piston housing section via the first piston housing section side wall apertures, the second end of the external flow channel being in fluid tight communication with the second piston housing section via the second piston housing section side wall apertures; whereby, (i) when a liquid is disposed within the first piston housing section, the application of an axial force to the braking wheel causes the rotation of the at least one braking wheel and its braking wheel axis to thereby move the piston from the first piston position towards the second piston position, the slide valve is closed and the piston pressurizes liquid out of the first piston housing section via the first piston housing section side wall apertures, and into the second piston housing section via the second piston housing section side wall apertures, and (ii) when the axial force on the at least one braking wheel is released, the first biasing means urges the piston from the second piston position towards the first piston position, the slide valve is opened and liquid returns to the first piston housing section from the second piston housing section via the piston flow channel.

Thus, when a liquid is disposed within the first piston housing section, the application of an axial force to the at least one braking wheel causes the rotation of the at least one braking wheel to thereby moves the piston from the first piston position towards the second piston position, the slide valve is closed and the piston pressurizes liquid out of the first piston housing section via the first piston housing section side wall apertures, and into the second piston housing section via the second piston housing section side wall apertures. Then, when the axial force on the at least one braking wheel is released, the first biasing means urges the piston from the second piston position towards the first piston position, the slide valve is opened and liquid returns to the first piston housing section from the second piston housing section via the piston flow channel.

DESCRIPTION OF THE DRAWINGS

These and other features, aspects and advantages of the present invention will become better understood with reference to the following description, appended claims and accompanying drawings where:

Figure 1 is a side view of an in-line skate having a braking mechanism with features of the invention;

Figure 2 is a front view of the in-line skate illustrated in Figure 1, shown in a skating orientation;

Figure 3 is a front view of the skate illustrated in Figure 1, shown in a braking orientation;

Figure 4 is a cross-sectional view of the braking mechanism portion of the skate illustrated in Figure 2, taken along line 4-4;

Figure 5 is a cross-sectional detail view of the first end of the braking mechanism illustrated in Figure 4, showing the first piston housing end disposed in abutment with the first end of the elongate body and showing the piston as it begins to move from the first piston position;

Figure 6 is a cross-sectional detail view of the first end of the braking mechanism illustrated in Figure 4, showing the first piston housing end disposed proximal to, but not in abutment with, the first end of the elongate body and showing the piston as it begins to move from the first piston position.

Figure 7 a cross-sectional detail view of the first end of the braking mechanism illustrated in Figure 4, showing the piston as it begins to move from the second piston position;

Figure 8 is a cross-sectional view of the braking mechanism illustrated in Figure 7, taken along line 8-8;

Figure 9 is a cross-sectional view of the braking mechanism illustrated in Figure 4, taken along line 9-9;

Figure 10 is a cross-sectional view of the braking mechanism illustrated in Figure 4, taken along line 10-10;

Figure 11 is a cross-sectional view of the braking mechanism illustrated in Figure 4, taken along line 11-11;

Figure 12 is a cross-sectional view of the braking mechanism illustrated in Figure 4, taken along line 12-12;

Figure 13 is a cross-sectional view of the braking mechanism illustrated in Figure 4, taken along line 13-13;

Figure 14 is a cross-sectional view of the braking mechanism illustrated in Figure 4, taken along line 14-14;

Figure 15 is a detail cross-sectional view of the braking mechanism illustrated in Figure 4, showing the piston initially disposed in a first position;

Figure 16 is a detail cross-sectional view of the braking mechanism illustrated in Figure 4, showing the piston initially disposed in a second position;

Figure 17 is a detail isometric view of a ball spline useable in the invention;

Figure 18 is a detail isometric view of a ball screw useable in the invention;

Figure 19 is a detail end view of the braking mechanism illustrated in Figure 4, taken along line 19-19;

Figure 20 is a detail cross-sectional side view of the forward end of the braking mechanism portion illustrated in Figure 4;

Figure 21 is a detail exploded view of a portion of the braking mechanism illustrated in Figure 4; and

Figure 22 is a side view of an ice skate having a braking mechanism with features of the invention.

DETAILED DESCRIPTION

The following discussion describes in detail one embodiment of the invention and several variations of that embodiment. This discussion should not be construed, however, as limiting the invention to those particular embodiments. Practitioners skilled in the art will recognize numerous other embodiments as well.

The invention is a braking mechanism **10** for a skate **12**, such as an in-line roller skate, a traditional roller skate or an ice skate. The invention is especially applicable as a braking mechanism for an in-line roller skate **12** as illustrated in Figures 1-21.

Figures 1 and 2 illustrate an in-line roller **12** skate having a boot **14** and four in-line skating wheels **16**. The skating wheels **16** are secured to a securing structure **18** which is attached to the boot **14**. The four in-line skating wheels **16** are aligned in a single line. The lowermost portion of each of the in-line skating wheels **16** provides a base skating surface **20** having a base skating surface longitudinal axis **22**.

The in-line skate **12** illustrated in Figure 1 further comprises the braking mechanism **10** of the invention, disposed below the boot **14**.

The braking mechanism **10** comprises at least one braking wheel **24**. In the embodiment illustrated in the drawings, the at least one braking wheel **24** is provided by a pair of braking wheels **24**. Each braking wheel **24** rotates about an axis **26**. The axis **26** is disposed

within a vertical plane. Typically, the vertical plane is directly aligned with the base skating surface longitudinal axis **22**. However, this is not strictly necessary. Embodiments in which the vertical plane is "cocked" slightly with respect to the longitudinal axis **22** are also possible, such as embodiments in which the vertical plane intersects the base skating surface longitudinal axis **22** at an angle between about -20° and about +20°, most typically between about -5° and about +5°.

Each of the braking wheels **24** has an identical diameter, typically between about 65% of the diameter of the skating wheels **16** and about 85% of the diameter of the skating wheels **16**. Each of the braking wheels **24** is disposed an equal distance above the base skating surface **20**, typically between about 2 mm and about 20 mm above the base skating surface **20**, and most typically between about 3 mm and about 16 mm above the base skating surface **20**. The diameter of the braking wheels **24** and the distance at which the braking wheels **24** are disposed above the base skating surface **20** are chosen so that a skater can simultaneously engage the braking wheels **24** and disengage the skating wheels **16** by tilting the skate **12**, as illustrated in Figure 3.

As illustrated in Figure 4, the braking mechanism **10** further comprises a braking piston **28** having a first piston end **30** and a second piston end **32**. The first piston end **30** is secured within a piston housing **34** and the second piston end **32** is secured to one or more ball splines **94** (described below). The first piston end **30** is separated from the second piston end **32** by a thrust bearing, ball or ball bearing **35**.

The piston housing **34** is disposed within an elongate body **37** having an elongate body first end **38** and an elongate body second end **40**. The piston housing **34** is retained within the elongate body **37** by a retainer cylinder **41** and a retaining nut **55**. To allow for the convenient installation of the piston housing **34** within the elongate body **37**, the

elongate body **37** is constructed from several assemblable elements as illustrated in Figure 21. The elongate body **37** further comprises a fill port **43** for filling the piston housing **34** with a suitable brake fluid and a bleed port **45** for bleeding air from the elongate body **37** during the filling of brake fluid into the piston housing **34**.

The piston housing **34** has piston housing side walls **42**, a first piston housing end **44** and a second piston housing end **46**. The piston housing **34** further comprises a first piston housing section **48** disposed proximal to the first piston housing end **44** and a second piston housing section **49** disposed distal to the first piston housing end **44**. The first piston housing end **44** comprises a locator pin **51** sized and configured to be retained within a locator bore **53** within the first end **38** of the elongate body **37**. The piston housing **34** is firmly retained within the elongate body **37** by the retainer cylinder **41** and the retaining nut **55** which is threaded over the retainer cylinder **41**.

The piston housing **34** is disposed within the elongate body **37** such that the first piston housing end **44** is disposed proximal to the first end **38** of the elongate body **37**. The specific location of the piston housing **34** within the elongate body **37** can be axially adjusted by backing off on the retaining nut **55** and rotating the retainer cylinder **41** in one direction or the other. Adjusting the specific location of the piston housing **34** with respect to the elongate body **37** affects the clearance between the first piston housing end **44** and the first end **38** of the elongate body **37**. Figure 5 illustrates a setting wherein the first piston housing end **44** is disposed in abutment to the first end **38** of the elongate body **37**. In this setting, there is no clearance between the first piston housing end **44** and the first end **38** of the elongate body **37**. Figure 6 illustrates a setting wherein the first piston housing end **44** is disposed proximal to, but not in abutment with, the first end **38** of the elongate body **37**. In this setting, there is clearance between the first piston housing end **44** and the first end **38** of the elongate body **37**. Once the piston housing **34** is specifically located within the elongate body **37**, the retaining nut

55 is secured to the retainer cylinder **41** by tightening a set screw **57** disposed within the retaining nut **55**.

As best understood with reference to Figures 5-8, the first piston housing section **48** defines a plurality of first piston housing section side wall apertures **50**. The plurality of first piston housing section side wall apertures **50** are defined within the side walls **42** in the first piston housing section **48** at a variety of different distances from the first piston housing first end **44**. Typically, each first piston housing side wall aperture **50** is round and has a diameter between about 0.5 mm and about 0.95 mm. In a typical embodiment, the side walls **42** in the first piston housing section **48** have between about 12 and about 24 first piston housing section side wall apertures **50**.

The piston housing side walls **42** in the second piston housing section **49** comprise one or more second piston housing section side wall apertures **52**. Typically, each second piston housing section side wall aperture **52** is round and has a diameter between about 1.2 mm and about 2.2 mm. In a typical embodiment, the side walls **42** in the second piston housing section **49** have between about 4 and about 10 second piston housing section side wall apertures **52**.

Disposed within the piston housing **34** is the first end **30** of the piston **28**. In the embodiments illustrated in the drawings, the piston **28** is movable within the piston housing **34** as will be described below.

The first end **30** of the piston **28** comprises an internal piston flow channel **54** for allowing the flow of liquids through the first end **30** of the piston **28**. A slide valve **56** is disposed in the first end **30** of the piston **28** for controlling the flow of liquid from the piston flow channel **54** to the first piston housing section **48**.

The piston **28** further comprises one or more piston inlet channels **58** for allowing the flow of liquid into the piston flow channel **54** from the second piston housing section **49**. Typically, each of the piston inlet channels **58** is round and has a diameter between about 1.2 mm and about 2.2 mm. In a typical embodiment, between about 4 and about 8 piston inlet channels **58** are disposed within the piston **28**.

A first biasing mechanism **60** is disposed within the piston housing **34** for urging the piston **28** towards the first piston position. In the embodiment illustrated in the drawings, the first biasing mechanism **60** is a coil spring **62**.

The slide valve **56** is adapted to close when the piston **28** is moved from the first piston position to the second piston position and to open when the piston **28** is moved from the second piston position to the first piston position. In the embodiment illustrated in the drawings, the piston flow channel **54** has an open end **64** at the first end **30** of the piston **28**. The slide valve **56** comprises a slidable plug **66** which is slidably disposed and retained within the piston flow channel **54**. The slidable plug **66** comprises an elongate body **68** and an end cap **70**. The slidable plug **66** is slidable between a first plug position wherein the end cap **70** covers the open end **64** of the piston flow channel **54** and a second plug position wherein the end cap **70** does not cover the open end **64** of the piston flow channel **54**. In the embodiment illustrated in the drawings, a second biasing mechanism **72** is disposed within the piston flow channel **54** for urging the slidable plug **66** to the first plug position. The second biasing mechanism **72** is typically weaker than the first biasing mechanism **60**. In the embodiment illustrated in the drawings, the second biasing method is a coil spring **74**.

Sealing means **76** are provided in the braking mechanism **10** for sealing the piston **28** within the piston housing **34** such that liquid disposed in the first piston housing section **48** cannot leak around the piston **28** to the second piston housing section **49**.

The sealing means **76** further assure that, when the piston **28** is moved adjacent to one of the plurality of first piston housing section side wall apertures **50**, liquid disposed in the first piston housing section **48** cannot leak around the piston **28** and out through the first piston housing side wall section aperture **50**.

In the embodiment illustrated in the drawings, the sealing means **76** can be provided by O-rings **78**. One or more of the sealing means **76** may also be provided by close tolerances between adjoining surfaces. For example, an O-ring **78** can be replaced by close tolerances between the piston **28** and the piston housing **34**, such as by constructing the piston **28** and the piston housing **34** with tolerances between about 0.005 mm and about 0.010 mm.

The braking mechanism **10** further comprises an external flow channel **80** disposed externally of the interior of the first piston housing section **48** and the second piston housing section **49**. The external flow channel **80** has a first end **82** and a second end **84**. The first end **82** of the external flow channel **80** is disposed in fluid tight communication with the first piston housing section **48** via the first piston housing section side wall apertures **50**. The second end **84** of the external flow channel **80** is disposed in fluid tight communication with the second piston housing section **49** via the second piston housing section side wall apertures **52**.

In the embodiment illustrated in the drawings, the first piston housing section **48** further defines a piston housing end aperture **86**. In a typical embodiment, the piston housing end aperture **86** defines an open area between about 2 mm and about 4 mm. The piston housing end aperture **86** is capable of being disposed in fluid tight communication with the first end **82** of the external flow channel **80**.

In the embodiment illustrated in the drawings, the piston **28** further comprises a tapered projection **88** which is aligned with the piston housing end aperture **86** such that, when the piston **28** is disposed in the second piston position, the tapered projection **88** is disposed within the piston housing end aperture **86** to reduce the open area of the piston housing end aperture **86**. In one embodiment of the invention, the tapered projection **88** seals the piston housing end aperture **86** when the piston **28** is fully disposed in the second piston position.

The piston **28** is mechanically connected to each of the braking wheels **24** such that the rotation of the braking wheels **24** moves the piston **28** within the piston housing **34** between (i) a first piston housing position wherein the piston **28** is distal from the first piston housing end **44** and wherein the piston **28** is not adjacent to the first piston housing section side wall apertures **50**, and (ii) a second piston housing position wherein the piston **28** is proximal to the first piston housing end **44** and the piston **28** is adjacent to some or all of the first piston housing section side wall apertures **50**.

In the embodiment illustrated in the drawings, the piston **28** is mechanically connected to each of the braking wheels **24** in a way best understood from Figures 4 and 9-16. Each braking wheel **24** has a built-in braking wheel gear **90** disposed coaxially with the braking wheel **24**. The braking wheel gear **90** meshes with a piston gear **92** which rotates about the piston **28**. The piston gear **92** is operatively connected to the second end **32** of the piston **28** so that the rotation of the piston gear **92** rotates the second end **32** of the piston **28**.

In the embodiment illustrated in the drawings, the piston gear **92** is operatively attached to the second end **32** of the piston **28** via a ball spline **94**. The ball spline **94** is shown in detail in Figure 17. The ball spline **94** comprises an inner cylinder **96** having an interior surface **98** and an exterior surface **100**. The interior surface **98** of the inner cylinder **96** has three parallel longitudinal notches **102** which are sized and dimensioned to retain three parallel

longitudinal ridges **104** disposed on the exterior surface of the second end **32** of the piston **28** in the vicinity of the ball spline **94**. The exterior surface **100** of the inner cylinder **96** of the ball spline **94** defines a plurality of ball bearing races **106** wherein are disposed a plurality of ball bearings **108**. The ball bearings **108** support the ball spline **94** on the second end **32** of the piston **28** and allow the piston **28** to freely travel in an axial direction while the ball spline **94** remains at a fixed location. The ball spline **94** also comprises an outer cylinder **110** which fully surrounds the ball bearing races **106**. The outer cylinder **110** is affixed to the inner cylinder **96**. The outer cylinder **110** defines a longitudinal key way **112**. Disposed within the key way **112** is a key **114**. The key **114** operatively connects the outer cylinder **110** of the ball spline **94** to the piston gear **92**. Ball splines are available from a variety of manufacturers, including from THK Company of Tokyo, Japan. Thus, it can be seen that the rotation of the braking wheels **24** rotates the piston gear **92** (because of the cooperation between the braking wheel gear **90** and the piston gear **92**), the rotation of the piston gear **92** causes the rotation of the ball spline **94** rotates the second end (via the connection of the piston gear **92** to the ball spline **94** with the key **114**) and the rotation of the ball spline **94** rotates the second end **32** of the piston **28** (due to the rotation of the longitudinal notches **102** disposed within the interior surface **98** of the inner cylinder **96** against the longitudinal ridges **104** disposed on the exterior surface of the piston **28**).

When the rotation of the braking wheel **24** causes the rotation of the second end **32** of the piston **28** as described immediately above, the second end **32** of the piston **28** is caused to travel axially due to the rotation of the second end **32** within a ball screw **116** or similar device. A typical ball screw **116** is illustrated in Figure 18. In the vicinity of the ball screw **116**, the second end **32** of the piston **28** is provided with a helical groove **118**. Within the ball screw **116**, a plurality of ball bearings **120** acts as screw teeth within the helical groove **118** to translate the rotation of the second end **32** of the piston **28** into axial motion. As can be seen from Figure 18, in a typical ball screw **116**, the ball bearings **120** are caused to travel

from one end of the ball screw **116** to the other, and are thereupon transferred to the opposite end of the ball screw **116** via an internal groove **122** disposed within the body of the ball screw **116**. Ball screws are available from a variety of manufacturers, including from THK Company of Tokyo, Japan. Because of the interaction of the second end **32** of the piston **28** with the ball spline **94** and the ball screw **116**, it can be seen that the rotation of the braking wheel **24** causes the piston **28** to travel towards the second piston position.

As can be understood from Figures 15 and 16, the first piston position can be adjusted relative to the piston housing **34**. This is accomplished by rotating an adjustment screw **124** disposed at the second end **32** of the piston **28**. Adjusting the location of the first piston position affects the length of travel between the first piston position and the second piston position.

In operation, the user initially opens the fill port **43** and the bleed port **45** and fills the piston housing **34** with a suitable brake fluid such as DOT 3, marketed by First Brands Corporation of Danbury, Connecticut. The user then adjusts the specific location of the piston housing **34** within the elongate body **37** by rotating the retainer cylinder **41** and loosening the set screw **57**, backing off the retaining nut **55** and sliding the piston housing **34** with respect to the elongate body **37**. Once the piston housing **34** is properly located within the elongate body **37**, the user tightens down on the retaining nut **55** and secures the retaining nut **55** with the set screw **57**. The user next adjusts the location of the first piston position by adjusting the adjustment screw **124** in one direction the other. Once these two adjustments are accomplished, the user then places the skates **12** on his or her feet and commences to skate. When the user wishes to stop his or her forward motion, the user tilts one of the skates **12** as illustrated in Figure 3. When one of the skates **12** is tilted as is illustrated in Figure 3, the skating wheels **16** are raised up above the base skating surface **20** while the braking wheels **24** are lowered to the brake skating surface **20**. By lowering the braking wheels **24** to the brake

skating surface **20**, the contact of the braking wheels **24** with the brake skating surface **20** causes the braking wheels **24** to rotate. The rotation of the braking wheels **24** is translated to the linear motion of the piston **28** via the braking wheel gear **90**, the ball spline **94** and the ball screw **116**. The linear motion of the piston **28** is from the first piston position towards the second piston position. As the piston travels from the first piston position towards the second piston position as illustrated in Figure 5 or Figure 6, braking fluid is displaced from the first piston housing section **48** to the external flow channel **80** via the first piston housing side wall apertures **50** (Figure 5) or via both the first piston housing section side wall apertures **50** and the piston housing end aperture **86** (Figure 6). The movement of the piston **28** towards the second piston position also displaces braking fluid from the external flow channel **80** into the second piston housing section **49** via the second piston housing section side wall apertures **52**. Braking fluid within the second piston housing section **49** is displaced into the piston flow channel **54** via the piston inlet channels **58**. As the piston **28** approaches the second piston position, the rate at which braking fluid is displaced from the first piston housing section **48** is markedly reduced because the piston **28** begins to seal off an increasing number of first piston housing section side wall apertures **50**. As the rate of displacement of the braking fluid is decreased, the linear travel of the piston **28** is resisted by a pressure which builds up within the first piston housing section **48**. This resistance to the travel of the piston **28** is translated to a resistance to the rotation of the braking wheels **24**. The resistance to the rotation of the braking wheels **24** acts to brake the forward momentum of the skater. Once the skater returns to a normal skating operation wherein the braking wheels **24** are raised up above the base skating surface **20**, the first biasing mechanism **60** urges the piston **28** to return to the first piston position. As this occurs (see Figure 7), fluid pressure in the second piston housing section **49** opens the end cap **70** so that braking fluid can quickly be displaced from the second piston housing section **49** back into the first piston housing section **48**.

As illustrated in Figure 22, the braking mechanism of the invention can be used on an ice skate.

Example

In one illustrative example of the invention, a boot **14** of a size 10 has skating wheels **16** with diameters of 72 mm. The diameters of the braking wheels **24** are 57 mm. The distance between the braking wheels **24** and the base skating surface **20** is 14.85 mm, the first piston housing section side wall apertures **50** have diameters of 0.79 mm and are 18 in number. The second piston housing section side wall apertures **52** have diameters of 1.6 mm and are 6 in number. The diameter of the piston housing end wall aperture **86** is 2.78 mm. The piston inlet channels **58** have a diameter of 1.6 mm and are 6 in number.

Having thus described the invention, it should be apparent that numerous structural modifications and adaptations may be resorted to without departing from the scope and fair meaning of the instant invention as set forth hereinabove and as described hereinbelow by the claims.